Range extension of the Little Forest Bat *Vespadelus vulturnus* (Chiroptera: Vespertilionidae) into a semi-arid area of central Queensland, Australia

R. A. Young[1] **and G. I. Ford**[2]

[1]Biology Department, University of Southern Queensland, Toowoomba, Queensland 4350
[2]Department of Environment, 158 Hume Street, Toowoomba, Queensland 4350

ABSTRACT

A northward range extension of approximately 500 km of the Little Forest Bat *Vespadelus vulturnus* was recorded during a fauna survey at Idalia National Park, central western Queensland. Idalia NP lies in the semi-arid zone and is bounded by latitudes 24°30' to 25°20' South. Forty seven *V. vulturnus* (24 females and 23 males) were captured in harp traps set in five different vegetation formations. Bats were captured in riverine woodland near water and in woodland to open forest habitats well away from water. The mean forearm length of 19 males (24.7 mm) was significantly ($p < 0.001$) shorter than the mean forearm length of 22 females (25.8 mm). The mean head-vent length of males and females ($n = 25$) was 36.9 mm. *Vespadelus vulturnus* from Idalia NP is Australia's smallest mammal and on the basis of forearm length is within the size range of Kitti's Hog-nosed Bat *Craseonycteris thonglongyai* which is reported to be the world's smallest mammal.

Key Words: Australia, Bat, Queensland, *Vespadelus vulturnus*, Range extension, Semi-arid zone, Latitudinal size variation, Smallest mammal.

INTRODUCTION

Until the studies of Kitchener (1976) and McKean *et al.* (1978) only a single species of *Eptesicus (E. pumilus)* was recognized in Australia. Iredale and Troughton (1934) proposed the generic name *Vespadelus* for *Scotophilus pumilus* (= *E. pumilus*), and this remained the *nomen nudum* until Troughton (1943) provided a description. On the basis of chromosomal studies, Volleth and Tidemann (1991) confirmed that the nine currently recognized species in this complex in Australia (Adams *et al.* 1987; Kitchener *et al.* 1987) are members of an endemic genus, *Vespadelus*. The nine species are: *V. baverstocki, V. caurinus, V. darlingtoni, V. douglasorum, V. finlaysoni, V. pumilus, V. regulus, V. troughtoni,* and *V. vulturnus*.

The distribution of *V. vulturnus* is generally regarded as being restricted to southeastern Australia (Fig. 1), from the Queensland-New South Wales border to the Fleurieu Peninsula of South Australia and Tasmania (Kitchener *et al.* 1987; Reardon and Flavel 1987; Tidemann 1995). The species is widespread in the Western Division of New South Wales (Dickman *et al.* 1993), and has been recorded in semi-arid northwestern Victoria (Lumsden and Bennett 1995). Thomson (1982) reported *Vespadelus vulturnus* from the Alice Springs area of the Northern Territory, although this record is now doubtful (probably *V. baverstocki*), given the extensive review of *Vespadelus* by Kitchener *et al.* (1987).

In southeastern Australia, *V. vulturnus* occurs in a variety of forest habitats below about 1 000 m elevation (Tidemann 1995). In Tasmania, Taylor and O'Neill (1986) recorded *V. vulturnus* in Blackwood *Acacia melanoxylon* swamps, dry sclerophyll forest and coastal mallee dominated by *Eucalyptus amygdalina,* but it was absent from cool temperate rainforest. Brown and Howley (1990) reported *V. vulturnus* in rainforest in Victoria. In the semi-arid mallee region of Victoria, Lumsden and Bennett (1995) found it in woodland and shrubland habitats near large water bodies. The species also occurs in Brigalow *Acacia harpophylla* communities in semi-arid northwestern New South Wales (Ellis and Wilson 1992).

The purpose of this paper is to report a range extension for *V. vulturnus* in eastern Australia of approximately 500 km northward into a semi-arid region of central Queensland. Data on body morphometrics, habitat selection and geographical variations in body size are also presented.

STUDY AREA AND METHODS

The study was conducted during April, September and November of 1995, in Idalia National Park, approximately 85 km west-south-west of Blackall, in the semi-arid zone of Queensland, Australia. The park is bounded by latitudes 24°30'-25°20' South and longitudes 144°30'-145°00' East (Fig. 1) and covers approximately 146 000 ha. Idalia lies

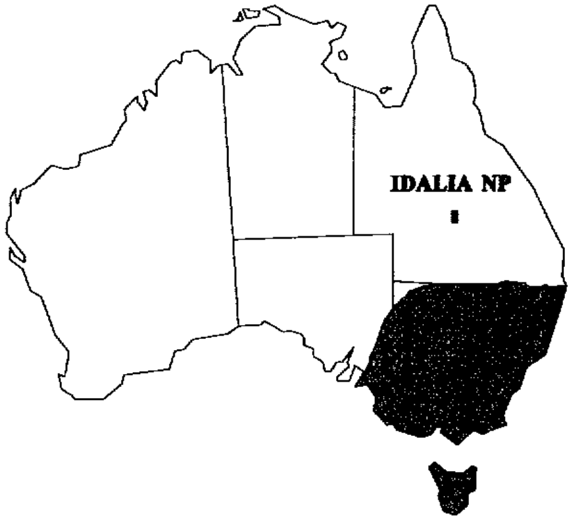

Figure 1. Distribution of *Vespadelus vulturnus* (after Parnaby 1992) and location of Idalia National Park.

on the northern edge of the Mulga Lands Biogeographic Region, its northern boundary following that of the Mulga Lands and Mitchell Grass Downs Biogeographic Regions (Addicott 1995; Thackway and Cresswell 1995).

The topography, soils and vegetation within the park are quite complex with 18 different land systems represented (QDPI 1980). A prominent feature of the park is the Gowan Range with rocky escarpments rising to 300 m above the surrounding plains. Vegetation in and around Idalia National Park has been described by QDPI (1980), Neldner (1984) and Addicott (1995), who recognized 54 different floristic communities within the park.

The climate is hot and dry with a summer maximum rainfall. The average annual rainfall varies over the park from 400 mm to 475 mm (Purdie 1984). Temperature data from Isisford, 105 km north of Idalia (nearest available records), show an average daily temperature range in summer of 21.5°C–36.0°C, and a winter daily average temperature range of 6.2°C to 25.1°C (Clewitt *et al.* 1994).

Bats were captured using harp traps (modified from the design of Tidemann and Woodside 1978). Captured bats were weighed (0.1 g) with a triple beam balance, and body measurements were taken with dial callipers (0.1 mm), following the procedure of Kitchener *et al.* (1987). All bats, except four voucher specimens, were released at the point of capture. The four voucher specimens were fixed in 10% buffered formalin for 48 hours and then transferred to 70% alcohol.

Published mean forearm lengths, with accompanying standard deviations, from southeastern Australia were analysed by one-way ANOVA, followed by the Newman-Keuls Test at the 1% level. Mean external body measurements and weights for animals examined at Idalia National Park were compared using Student's t-Test.

RESULTS

During the survey at Idalia National Park 47 (24 female and 23 male) adult *V. vulturnus* (Plate 1A) were captured in harp traps set in five different vegetation formations (Table 1). The total number of *V. vulturnus* captured per trap-night was 2.24. This is apparently the first published record of *V. vulturnus* for Queensland and represents a northward range extension in eastern Australia of approximately 500 km.

a) Habitat selection

Data on habitat selection are presented in Table 1. The majority (61.7%) of *V. vulturnus* were captured in traps set in a dry creek bed near a permanent waterhole (Site #1). The vegetation at this site is riverine woodland dominated by mature River Red Gum *Eucalyptus camaldulensis* and Brigalow *Acacia harpophylla* (Plate 1B). The vegetation on a nearby rocky ridge is dominated by Bendee *A. catenulata* to 8 m high. Bats were also

Table 1. Sites, habitats, numbers of *Vespadelus vulturnus*, and trapping effort at Idalia National Park, 1995.

Site #	Location	Vegetation formation	Males	Females	Total	Distance to water (km)	Number per trapnight (TN)	Number TN
1	Mountain Hole	Riverine woodland	17	12	29	0	9.67	3
2	20 Mile Creek	Riverine open woodland	1	1	2	5.4	1.0	2
5	Track to Reedy Spring	Mulga open forest	0	6	6	6.5–8.2	1.50	4
8	Chucksters	Mixed open woodland	0	2	2	2	2.0	1
10	Airstrip Dam	Riverine woodland-open forest	5	3	8	0	0.73	11
		Total	23	24	47		2.24	21

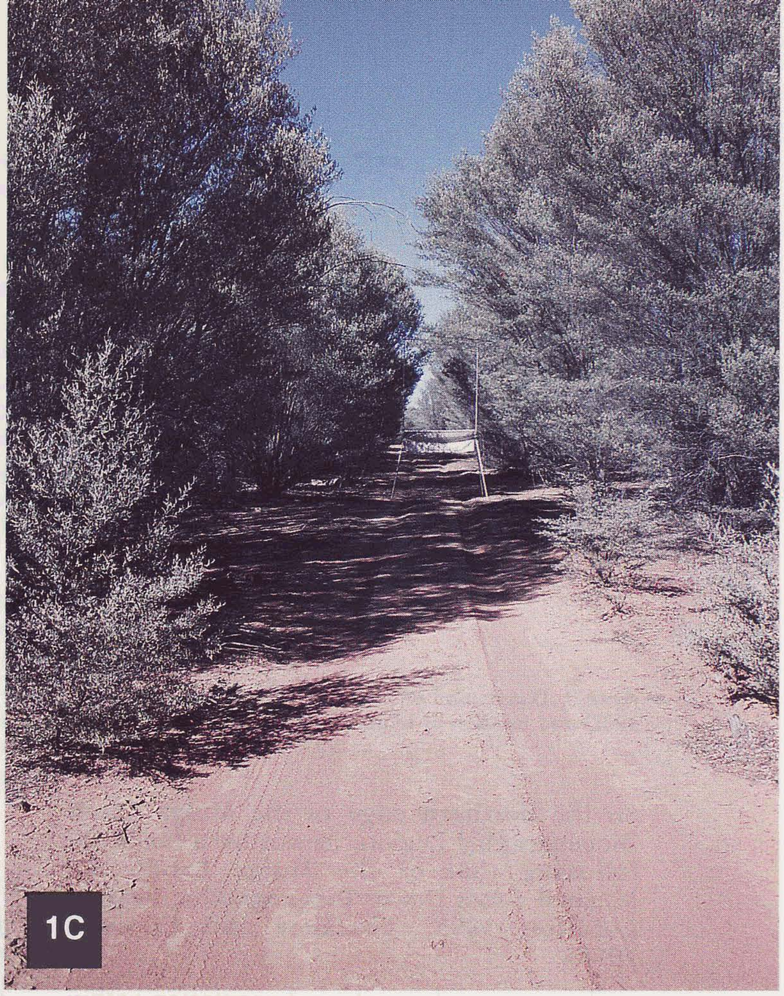

Plate 1A. Adult female *Vespadelus vulturnus* captured in a bat trap at Idalia National Park, September 1995.

Plate 1B. Riverine woodland community at Mountain Hole (Site #1) where the majority of *Vespadelus vulturnus* were captured.

Plate 1C. Bat traps set in a Mulga (*Acacia aneura*) open forest community at Idalia captured six *Vespadelus vulturnus*.

captured in other riverine open woodland to open forest habitats, both near to and distant from water. In early November 1995, six heavily pregnant females were captured between 6.5 km and 8.2 km from the nearest water, in an open forest dominated by Mulga *A. aneura* to 9 m high (Site #5; Plate 1C). During the same sampling period two heavily pregnant females were captured about 2 km from water, in a mixed open woodland dominated by Poplar Box *E. populnea* and Mulga (Site #8).

Table 2. External morphometric data for *Vespadelus vulturnus* from Idalia National Park. Values are means ± standard deviations, with range in parentheses.

Character	Male	n	Female	n	Significance
Forearm (mm)	24.7 ± 0.7 (23.5–26.7)	19	25.8 ± 0.7 (23.9–27.2)	22	$p < 0.001$
Metacarpel III (mm)	22.6 ± 0.8 (21.5–23.5)	9	23.7 ± 0.6 (22.7–25.1)	14	$p < 0.001$
Phalanx I (mm)	10.7 ± 0.7 (9.4–11.4)	9	11.0 ± 0.6 (10.3–12.6)	14	n.s.
Phalanx II (mm)	8.0 ± 0.8 (6.4–9.3)	9	8.2 ± 0.5 (7.4–9.0)	14	n.s.
Phalanx III (mm)	6.4 ± 0.5 (5.4–6.8)	8	6.5 ± 0.6 (5.5–7.8)	14	n.s.
Ear length (mm)	8.3 ± 0.7 (7.5–9.8)	9	8.7 ± 0.62 (7.7–10.1)	11	n.s.
Tragus length (mm)	3.8 ± 0.5 (3.3–4.8)	7	3.9 ± 0.6 (3.0–4.9)	9	n.s.
Head-Vent (mm)	37.3 ± 1.5 (35.0–39.2)	9	36.8 ± 2.5 (31.5–40.3)	16	n.s.
Tail (mm)	27.8 ± 1.4 (25.8–29.7)	9	28.2 ± 1.3 (25.5–30.4)	16	n.s.
Tibia length (mm)	11.6 ± 0.6 (11.0–13.0)	9	11.4 ± 0.6 (10.4–12.7)	16	n.s.
Hindfoot (mm)	5.0 ± 0.5 (4.4–5.7)	9	4.7 ± 0.5 (4.0–5.5)	14	n.s.
Weight (g)	3.0 ± 0.3 (2.7–3.5)	6	3.9 ± 0.7 (3.0–4.8)	16	$p < 0.001$

b) Body morphometrics

External body measurements and weights are given in Table 2. The mean forearm length of 19 males (24.7 mm) was significantly ($p < 0.001$) shorter than the mean forearm length of 22 females (25.8 mm). The mean length of metacarpal III of digit III was significantly shorter ($p < 0.001$) in males than in females. The mean weight of females (3.9 g) was significantly higher ($p < 0.001$) than that of males (3.0 g), because all the females weighed ($n = 13$) in early November were overtly pregnant. There were no significant differences between males and females with respect to all other external body measurements (Table 2).

c) Regional variation in forearm length

Forearm lengths of *V. vulturnus* from six different geographical regions were compared to determine if there was a clinal variation with latitude (Tables 3 and 4). Forearm measurements of males and females in each region were combined for the statistical analysis because sample sizes were small from three regions. Pooling the measurements for each sex also eliminates the possible influence of sexual dimorphism on the analysis. The largest and smallest bats were recorded in Tasmania and central Queensland (Idalia) respectively. There was no evidence of a gradual clinal increase in forearm length from lower (central Queensland) to higher latitudes (Tasmania) because bats from Victoria and South Australia were significantly ($p < 0.01$) smaller than those from northern New South Wales (Table 4). The mean forearm length of bats from the Victoria/South Australia sample were not significantly different from the southern New South Wales sample ($p > 0.01$). All other differences in forearm length were significant ($p < 0.01$) (Table 4). However, larger sample sizes from

Table 3. Regional variation in forearm lengths of *Vespadelus vulturnus* in eastern Australia. See Table 4 for statistical analysis of these data.

Location	Mean (mm)	SD	n	Reference
Central Queensland (Idalia NP)	25.3	0.87	47	This study
N New South Wales	28.4	0.72	10	Kitchener *et al.* 1987
Victoria and South Australia	27.6	0.78	5	Kitchener *et al.* 1987
S New South Wales	27.6	0.79	8	Kitchener *et al.* 1987
Victoria (Mallee)	26.5	0.8	238	Lumsden and Bennett 1995
Tasmania	29.3	0.7	70	O'Neill and Taylor 1986

Table 4. Statistical analysis of forearm length of *Vespadelus vulturnus* in eastern Australia. * = Significant at 1% level (Newman-Keuls Test); n.s. = not significant.

	Central Queensland (Idalia	Victoria Mallee	S New South Wales	Victoria and South Australia	N New South Wales
Victoria Mallee	*	–	*	*	*
S New South Wales	*	*	–	n.s.	*
Victoria and South Australia	*	*	n.s.	–	*
N New South Wales	*	*	*	*	–
Tasmania	*	*	*	*	*

some regions (e.g., northern New South Wales, Victoria and South Australia, and southern New South Wales) would be required to determine if these differences are real inter-population differences and not just an artefact caused by small sample sizes.

DISCUSSION

The occurrence of *V. vulturnus* at Idalia represents a significant northward range extension (about 500 km) for this species in eastern Australia. There are no published reports of *V. vulturnus* occurring in Queensland. However, recent unpublished records indicate that it may occur elsewhere in the state (M. Schulz and B. Thomson, pers. comm.). A more widespread distribution within Queensland could be expected, based on its widespread occurrence in northwestern New South Wales (Dick and Andrew 1993; Dickman *et al.* 1993; Ellis and Wilson 1992; Parnaby *et al.* 1989; Smith 1993). Further surveys are needed to clarify the distribution of this species in Queensland.

Considerable sexual dimorphism in forearm length was evident in the Idalia population, with females being larger than males (Table 2). Lumsden and Bennett (1995) noted a similar size dimorphism in this species in the mallee region of northwestern Victoria.

Latitudinal and longitudinal clines in body size have been well documented for many species of vertebrates. Tidemann (1986) found that *Chalinolobus gouldii* increased in size with increasing latitude, but concluded that the discontinuities in the east-west cline were difficult to interpret, and may be due to climatic discontinuities or barriers to gene flow. Kitchener and Caputi (1985) demonstrated longitudinal and latitudinal clines in body size for four species of *Scotorepens*. *S. sanborni* became larger from west to east while the trend for *S. greyii* was the opposite. However, these clinal variations in body size were also related to climatic severity; *S. orion* and *S. sanborni* increased in size with increased climatic severity but *S. greyii* and *S. balstoni* became smaller.

In southeastern Australia, Taylor *et al.* (1987) found significant differences between the forearm lengths of eight species from Tasmania, compared with conspecifics from the southeastern mainland. However, it was not a simple clinal variation along a latitudinal gradient. The smallest species of *Vespadelus* and *Chalinolobus* are significantly larger, and the largest species smaller, in Tasmania compared with conspecifics on the mainland.

Although the smallest and largest forearm lengths recorded for *V. vulturnus* occurred at the extreme ends of the latitudinal range of this species in eastern Australia, there was no gradual clinal increase in forearm length with increasing latitude. Forearm length of *V. vulturnus* from the semi-arid areas of central Queensland (Idalia) and the mallee region of Victoria are significantly smaller than for conspecifics from the more mesic areas of southeastern Australia (Table 3 and 4). Lumsden and Bennett (1995) noted that the forearm lengths of five species of bats trapped in the mallee region of Victoria were significantly smaller than for conspecifics captured in temperate environments of southern Victoria. In their analysis of the characteristics of semi-arid bat assemblages, Lumsden and Bennett (1995) noted that there is a higher percentage of smaller species of bats in semi-arid regions compared with more mesic (temperate to tropical) regions.

On the basis of the measurements in this study, *V. vulturnus* from Idalia National Park is Australia's smallest mammal. Using forearm length, *V. vulturnus* is within the size range of Kitti's Hog-nosed Bat *Craseonycteris thonglongyai*, which is reported to be the world's smallest bat and probably the world's smallest mammal (Nowak 1991). Its forearm length is 22–26 mm (Nowak 1991) compared with 23.5–27.2 mm for *V. vulturnus* from Idalia (Table 2). The head-vent length of *C. thonglongyai* is considerably smaller (29–33 mm) than that of *V. vulturnus* (31.5–40.3 mm). The mean weight of male and non-pregnant female *V. vulturnus* was 3.2 g ± 0.41 g SD (r = 2.7–4.0 g; n = 14), compared with a weight range of 1.5–3.0 g for *C. thonglongyai* (Parker 1990). For comparative purposes, measurements of long bones (e.g., radius) tend to be more reliable or consistent than head-vent measurements or weight.

ACKNOWLEDGEMENTS

We wish to thank H. Young, P. McConnell and M. Mathieson for their assistance in the field, often under very difficult conditions. The hospitality of Col and Maureen Morgan, rangers and excellent hosts at Idalia, was much appreciated. We also thank Dr D. J. Kitchener for confirming the identification of the voucher specimens; H. Eastment for statistical advice; Mike Harris, Roger Turnbull and Mark Weaver, of the Queensland Department of Environment, for organizing and issuing scientific permits; and Bruce Thomson for comment on the draft manuscript. Our appreciation also to the two anonymous referees for advice on improvements to the manuscript. The initial discovery of *V. vulturnus* at Idalia was made during a fauna survey of the Mitchell Grass Downs Biogeographic Region, funded by the Australian Heritage Commission (National Estate Grants Program).

REFERENCES

Adams, M., Baverstock, P. R., Watts, C. H. S. and Reardon, T., 1987. Electrophoretic resolution of species boundaries in Australian microchiroptera. I. *Eptesicus* (Chiroptera: Vespertilionidae). *Aust. J. Biol. Sci.* **40:** 143–62.

Addicott, E., 1995. Idalia National Park Vegetation Report. Internal Report, Queensland Department of Environment and Heritage.

Brown, G. W. and Howley, S. T., 1990. The bat fauna (Chiroptera: Vespertilionidae) of the Acheron Valley, Victoria. *Aust. Mammal.* **13:** 65–70.

Clewitt, J. F., Clarkson, N. M., Owens, D. T. and Abrecht, D. G., 1994. *Australian Rainman: Rainfall Information for Better Management.* Department of Primary Industries: Brisbane.

Dick, R. and Andrew, D., 1993. *A Vertebrate Fauna Survey of the Culgoa Birrie River Floodplains in New South Wales 1990–1992.* New South Wales National Parks and Wildlife Service, Occasional Paper No. 14.

Dickman, C. R., Pressey, R. L., Lim, L. and Parnaby, H. E., 1993. Mammals of particular conservation concern in the Western Division of New South Wales. *Biol. Cons.* **65:** 219–48.

Ellis, M. and Henle, K., 1988. The mammals of Kinchega National Park western New South Wales. *Aust. Zool.* **25:** 1–5.

Ellis, M. and Wilson, P., 1992. *An overview of the vertebrate fauna of the Brigalow Belt north-east of Bourke, New South Wales.* Unpublished report to Australian Heritage Commission for Royal Zoological Society of New South Wales.

Iredale, T. and Troughton, E. le G., 1934. A checklist of the mammals recorded from Australia. *Aust. Mus. Sydney Mem.* No. 6.

Kitchener, D. J. and Caputi, N., 1985. Systematic revision of Australian *Scoteanax* and *Scotorepens* (Chiroptera: Vespertilionidae), with remarks on relationships to other Nycticeiini. *Rec. West. Aust. Mus.* **12:** 85–146.

Kitchener, D. J., 1976. *Eptesicus douglasi*, a new vespertilionid bat from Kimberley, Western Australia. *Rec. West. Aust. Mus.* **4:** 295–301.

Kitchener, D. J., Jones, B. and Caputi, N., 1987. Revision of Australian *Eptesicus* (Microchiroptera: Vespertilionidae). *Rec. West. Aust. Mus.* **13:** 427–500.

Lumsden, L. F. and Bennett, A. F., 1995. Bats of a semi-arid environment in south-eastern Australia: biogeography, ecology and conservation. *Wildl. Res.* **22:** 217–40.

McKean, L. J., Richards, G. C. and Price, W. J., 1978. A taxonomic appraisal of *Eptesicus* (Chiroptera: Mammalia) in Australia. *Aust. J. Zool.* **26:** 529–37.

Neldner, V. J., 1984. *Vegetation Survey of Queensland — South Central Queensland.* Queensland Botany Bulletin No. 3, Queensland Department of Primary Industries.

Nowak, R. M., 1991. *Walker's Mammals of the World.* 5th Ed. Vol. 1. The John Hopkin's University Press.

Parker, S. P. (ed.), 1990. *Grzimek's Encyclopedia of Mammals.* Vol. 1. McGraw-Hill Publishing Co.: New York.

Parnaby, H. E., 1992. *An Interim Guide to Identification of Insectivorous Bats of South-eastern Australia.* Technical Report No. 8, Australian Museum: Sydney.

Purdie, R., 1984. Idalia National Park Proposal — Mulga Lands Biogeographic Region. Internal Report, Queensland Department of Environment and Heritage.

QDPI, 1980. *Western Arid Region Land Use Study — Part 2.* Technical Bulletin No. 22, Division of Land Utilisation, Queensland Department of Primary Industries.

Reardon, T. B. and Flavel, S. C., 1987. *A Guide to the Bats of South Australia.* South Australian Museum: Adelaide.

Robinson, A. C., Casperson, K. D., Canty, P. D. and MacDonald, C. A., 1988. A biological survey of the Gawler Ranges, South Australia in October 1985. Department of Environment and Planning, South Australia: Adelaide.

Smith, J., 1993. *A Report on the Vertebrate Fauna of the Narran River Floodplain in New South Wales.* Unpublished Report, New South Wales National Parks and Wildlife Service.

Taylor, R. J. and O'Neill, M. G., 1986. Composition of the bat (Chiroptera: Vespertilionidae) communities in Tasmanian forests. *Aust. Mammal.* **9:** 124–30.

Taylor, R. J., O'Neill, M. G. and Reardon, T., 1987. Tasmanian bats: identification, distribution and natural history. *Pap. Proc. Roy. Soc. Tas.* **121:** 109–19.

Thackway, R. and Cresswell, I. D., 1995. *An Interim Biogeographic Regionalisation for Australia: a framework for setting priorities in the National Reserves System Cooperative Program.* Australian Nature Conservation Agency: Canberra.

Thomson, B. G., 1982. Records of *Eptesicus vulturnus* (Thomas) (Vespertilionidae: Chiroptera) from the Alice Springs area, Northern Territory. *Aust. Mammal.* **5:** 69–70.

Tidemann, C. R., 1986. Morphological variation in Australian and island populations of Gould's Wattled bat, *Chalinolobus gouldii* (Gray) (Chiroptera: Vespertilionidae). *Aust. J. Zool.* **34:** 503–14.

Tidemann, C. R., 1988. A survey of the mammal fauna of the Willandra Lakes World Heritage region, New South Wales. *Aust. Zool.* **24:** 197–204.

Tidemann, C. R., 1995. Little Forest Bat *Vespadelus vulturnus* (Thomas 1914). In *The Mammals of Australia* ed by R. Strahan. Australian Museum/Reed Books: Sydney.

Tidemann, C. R. and Woodside, D. P., 1978. A collapsible bat trap and a comparison of results obtained with the traps and with mist nets. *Aust. Wildl. Res.* **5:** 355–62.

Troughton, E. le G., 1943. *Furred Animals of Australia.* 2nd Edition. Angus and Robertson: Sydney.

Volleth, M. and Tidemann, C. R., 1991. The origin of the Australian Vespertilioninae bats, as indicated by chromosomal studies. *Z. Saugetierkunde* **56:** 321–30.